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GB 2189800 A **US 5120088 A** **US 4897300 A**

(58) Field of Search
UK CL (Edition N) **B6A AK ATC**
INT CL^6 **B42D 15/00 , D21H 21/48 , G03C 5/08**

(54) Fluorescent security feature for cheques and banknotes

(57) The security feature comprises a transparent or translucent substrate 11 and two fluorescent components which fluoresce UV light at different visible colours and a UV light absorber. The fluorescent components may be in the form of coatings 12, 13 (Figs 1 and 2) or incorporated 15 in the substrate (Fig 3). The UV light absorber may be in the substrate 11 or as a layer 14 (Fig 2).

FIG. 1.

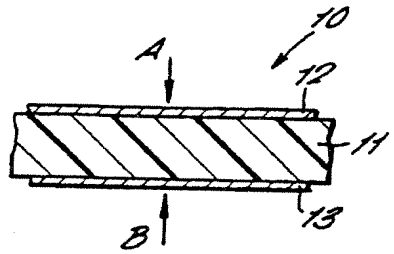


FIG. 2.

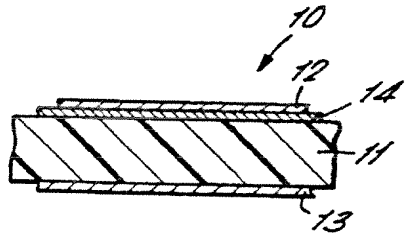
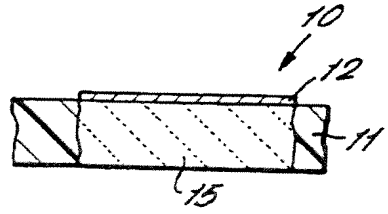


FIG. 3.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

FIG. 1.

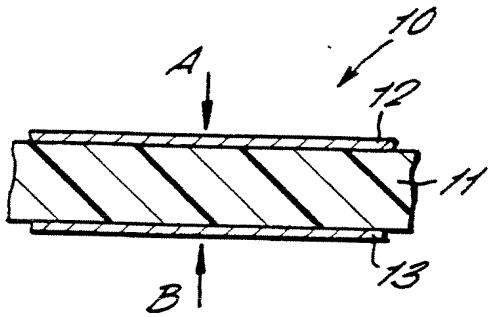


FIG. 2.

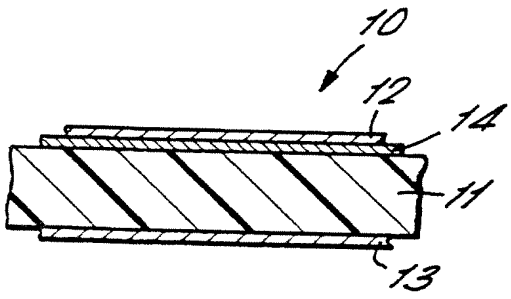


FIG. 3.

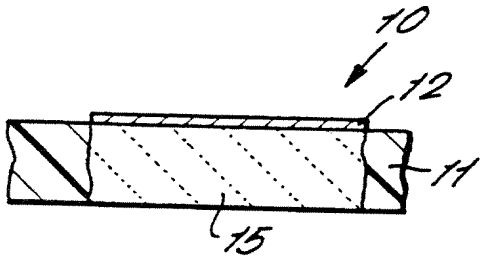
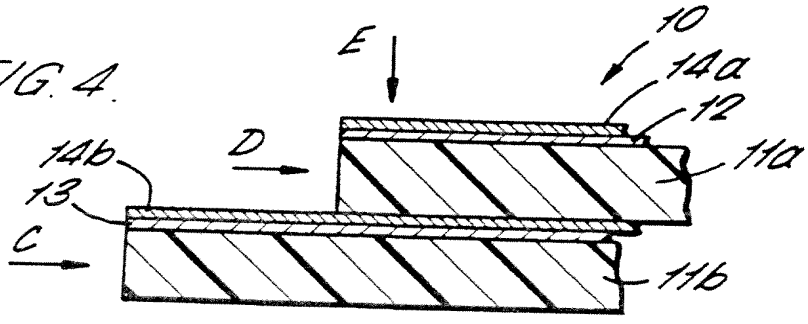


FIG. 4.



COMPOSITE MATERIAL HAVING FLUORESCENT FEATURES

The invention relates to a composite material having fluorescent features which can be used for security documents such as cheques and banknotes or for generating signs or signals. The invention also relates to a method for making such a composite material.

Documents, means of identification and security articles, such as banknotes, passports, identification cards, tickets, security packaging, coupons, vouchers and the like, are vulnerable to copying or counterfeiting. The increasing popularity of electronic copying devices such as colour photocopiers, scanners and other imaging systems, and the improving technical quality of colour copiers, has led to an increase in the counterfeiting of such articles. Digital imaging systems further increase this threat by permitting further manipulation of the image on a computer prior to it bring printed. There is, therefore, a need to improve the security features of such articles, or paper, to add additional security features or to enhance the perceptions and resistance to simulation of existing features. Steps have already been taken to introduce optically variable features into such documentation which cannot be reproduced by a photocopier. Such features include holograms, aluminium foil and colour shift inks and are usually very expensive in relation to other costs such as paper and printing. There is thus a demand to introduce features which are discernible by the naked eye but "invisible" to, or viewed differently by, a copier or scanner. Since copying or scanning processes typically involves reflecting high energy

light of an original document containing the image to be copied, one solution is to incorporate one or more features into the document which have a different perception in reflected and transmitted light. Known examples of such security features include watermarks, embedded security threads and the like.

An additional level of security can be provided by what are known as inspector level features. These are features which can be used to verify the genuineness of a document by using special equipment to view or detect the feature e.g. an ultraviolet lamp.

EP-A-0388090 describes a sheet of material having a security device comprising a see-through or print-through feature. Such features can be inspected visually in four different ways; a first image can be seen in reflected light on one side of the sheet, a second image can be seen in reflected light on the other side of the sheet, a combination of the first and second images can be viewed in transmitted light on each side of the sheet. The feature is provided in one area of the sheet which is essentially translucent.

One object of the present invention is to provide a material which has a different appearance in reflected and transmitted ultraviolet light.

According to the invention there is provided a composite material having fluorescent features comprising a transparent or translucent substrate, at least two fluorescent components, which fluorescent components fluoresce in ultraviolet light at different

visible colours, and at least one ultraviolet light absorbent component is incorporated with one of the fluorescent components or alternatively between them.

At least one of the fluorescent components is preferably incorporated in a fluorescent layer on a part of or the whole of one surface of the substrate.

Preferably the other fluorescent component is also incorporated in a fluorescent layer on a part of or the whole of an opposite side of the substrate.

In a preferred embodiment of the invention the other fluorescent component is incorporated in the substrate.

The ultraviolet light absorbent component may be contained in the substrate or incorporated in a layer between the substrate and one fluorescent layer.

Ultraviolet light absorbent component is preferably incorporated in a layer between each of the fluorescent coatings and substrate.

In another preferred embodiment of the invention there are a plurality of layers of substrate, on a surface of each of which is a fluorescent layer and a layer of ultraviolet absorber and in which each fluorescent layer is positioned between an ultraviolet absorbent layer and a layer of substrate.

The fluorescent component or components is or are applied to the material preferably in the form of one or more images, text or other indicia.

The fluorescent component or components may be partially overprinted with an ultraviolet light absorbent component.

The substrate is preferably a porous material and more preferably is paper or non-woven or plastic films.

According to a second aspect of the invention there is provided a method of making composite material comprising the steps as applying a resin composition to a porous transparent or translucent substrate, which composition comprises a fluorescent pigment and a fluorescent die, which pigment die fluoresce at different visible colours.

The resin composition preferably comprises an ultraviolet light absorbent component or alternatively the ultraviolet light absorbent component may be contained within the substrate.

A preferred embodiment of the present invention will now be described in detail, by way of example only, with references to the accompanying drawings in which:-

Fig. 1 is a sectional view of a composite material according to the invention;

Fig. 2 is a sectional view of an alternative material according to the invention;

Fig. 3 is a sectional view of a third alternative material according to the invention; and

Fig. 4 is a sectional view of a fourth alternative material according to the invention.

Referring to Fig. 1, there is shown a first embodiment of a composite material according to the present invention. This material 10 comprises a thin layer of substrate 11, the substrate preferably being a transparent or translucent plastic film or paper. The substrate 11 contains an ultraviolet light absorber which causes the substrate 11 to absorb significantly more light in the ultraviolet spectoral region than it would without the absorber. One example of a suitable ultraviolet light absorber is titanium dioxide, provided at a level of between 0.5 and 20% by weight. The ultraviolet light absorber can be introduced into the substrate 11 during its manufacture film or impregnated subsequently.

The composite material 10 further comprises a first fluorescent coating 12 on one surface of the substrate 11. The coating 12 consists of a binder material into which is incorporated a fluorescent pigment or dye. On the opposite side of the substrate 11 is a second fluorescent coating 13 which is of a similar composition to the first coating 12. However, the fluorescent pigment or dye for the second coating 13 is selected which fluoresces at a different wavelength, and therefore colour, than that in the first coating 12. The coatings 12, 13 are preferably as transparent as possible in visible light and may be applied by any appropriate method.

Ultraviolet light entering the surface of the composite material 10 produces a visible fluorescent colour that is emitted in all directions. The

ultraviolet absorbing material prevents the ultraviolet light from reaching the layer of fluorescent material beyond the layer of ultraviolet absorbing material. The only fluorescent colour seen is thus that in the coating between the ultraviolet absorber and the ultraviolet light source.

When the composite material 10 is viewed in reflected UV light from the direction of arrow A, the fluorescent colour of coating 12 will be seen. The ultraviolet light absorber in the substrate 11 prevents the light from reaching the second coating 13. If the same composite material 10 is viewed in transmitted ultraviolet light with the light placed at arrow B the fluorescent colour of coating 13 will be seen from a position at arrow A. Again the ultraviolet light absorber in the substrate 11 will prevent the ultraviolet light from reaching the first coating 12 and therefore remains transparent. Thus when the composite material 10 is viewed alternatively in transmitted and reflected ultraviolet light the fluorescent colour perceived by the viewer will change.

Furthermore, when the material 10 is viewed in either transmitted or reflected ultraviolet light, the fluorescent colour perceived by the viewer changes when the composite material 10 is turned over.

Thus it can be seen that the material provides a combination of colour changes depending on how it is viewed, which may be used as an effective security feature for paper or plastic film based security documents such as cheques and banknotes.

In recent times, plastic substrates have been used as substrates for security documents including banknotes. In such uses of the invention the coatings 12, 13 could also be printed indicia. The indicia may be printed on one or both sides of the substrate 11. Where the indicia is printed on both sides of the substrate 11, it may be different so that when viewed from the same side in reflected and transmitted light, different indicia are revealed. Furthermore, the coatings 12, 13 may or may not be fluorescent at the same wavelength. This would provide an unexpected and rather startling effect and would be particularly useful as a security feature.

A second embodiment of a composite material 10 according to the invention is illustrated in Fig. 2. In this material 10 the ultraviolet absorber is provided in a separate layer 14. Although Fig. 2 shows a single layer of ultraviolet absorber 14 beneath the first coating 12, a layer of ultraviolet absorber 14 may be incorporated beneath either of the fluorescent coating layers 12, 13 or a separate layer may be incorporated beneath each of the fluorescent coatings 12, 13. The layer(s) 14 may comprise pure ultraviolet absorber or an appropriate composition. The layer 14 may be a printed indicia in which case the colour change effect previously described will only be seen over the printed indicia.

The fluorescent coatings 12 and 13 may cover the entire surface of the composite material 10. Alternatively they can be printed on the substrate 11 so as to impart a specific image, text or other indicia. Alternatively the fluorescent coatings 12, 13 may additionally be overprinted in part with an

ultraviolet absorbing material such that only the part(s) of the fluorescent coating not masked by the over-printing receives the ultraviolet light and is thus able to fluoresce.

Fig. 3 illustrates a third alternative embodiment of a composite material according to the present invention. In this composite material 10 the substrate 11 contains an ultraviolet absorber and there is a single fluorescent coating 12 on one surface of the substrate 11. A second fluorescent material is provided, not in the form of a coating, but instead the substrate 11 is impregnated therewith.

To further explain this embodiment of the invention reference is made to co-pending patent application GB 9319872.9, of which we are joint applicants, which describes a method of making paper by applying a transparentising resin to the surface of a partially formed paper sheet to provide a transparentised area. This method can be adapted for use in the present invention (and therefore the contents of the specification of the aforesaid application should be considered to be included herein).

To make the composite material 10 of Fig. 3 a formulation comprising a transparent resinous carrier, a fluorescent pigment and a fluorescent dye is applied to the substrate 11. The two fluorescent materials are chosen such they they fluoresce at different wavelengths and therefore different colours. The substrate 11 must be a porous material; examples of which comprise a polymeric material such as a blown film with an open cell structure, a non-woven material

such as a spun bonded polyethylene, a dry layed non-woven paper, a wet layed non-woven paper or a porous paper. The substrate 11 contains an ultraviolet absorber, such as titanium dioxide. The resin formulation is applied as a coating or a printed image onto the surface of the substrate 11 by the method described in GB 9319872.9. The resin is chosen so that it has a viscosity and surface energy sufficiently low to permit it to absorb into the surface of the substrate 11.

This results in two effects. Firstly, the area 15 into which the resin is absorbed becomes translucent because air is excluded from the substrate 11. Secondly, the fluorescent pigment is filtered out of the resin during the absorption process and remains predominantly on the surface of the substrate 11 forming a fluorescent coating 12. The fluorescent dye, on the other hand, is not filtered out and is transported through area 15 of the substrate 11 with the resin. Thus the dye and the pigment are separated in situ by the absorption process.

The unexpected and surprising result of this process is a porous material that has a fluorescent image or coating that changes colour depending on which side it is viewed from and upon whether or not it is viewed in transmitted or reflected ultraviolet light. The advantage of the material 10 being partially transparentised is that the fluorescent colours can be seen more easily from either side. An additional advantage of this method is that the image seen in reflected or transmitted ultraviolet light is perfectly in register. Furthermore, slight lateral migration of the mobile phase may result in the

pigmented image being surrounded by a very thin halo of the fluorescent dye when viewed in reflected or transmitted UV light.

In a modification of the previous embodiment of the invention, the ultraviolet absorbing material may be incorporated into the resin formulation instead of the porous substrate 11. The advantage of this modification is that common substrates, such as printing paper, that frequently do not contain ultraviolet quenching materials can be used as a substrate in the present invention provided that the substrate itself is not fluorescent.

The method of presenting a resin onto an absorbent substrate as described in co-pending application GB 9319872.9 has one embodiment that describes the use of UV curable resins. This is clearly more complex when applied to the present invention because the UV absorbing layer will interfere with the UV curing process by inhibiting the penetration of UV light into the body of the substrate 11. If this problem is not addressed the result would be one of the following outcomes:-

a. an excess amount of UV energy would be required to cure the resin;

b. the resin will not fully cure and as a consequence will continue to migrate laterally through the paper. The result will be an ill-defined image with a lower degree of transparentisation.

This problem is solved by using the fact that the

various elements of the process work at different ends of the UV spectrum. By way of example, a UV absorber that is dominant in the short wavelength end of this spectra will not interfere appreciably with a UV source whose spectrum is predominantly in the near visible, long wavelength end of the UV spectra. Furthermore a combination of photoinitiators should be chosen which are activated by UV light at the near visible as well as the short wavelength portions of the UV spectrum. In general, photoinitiators and UV light sources should be chosen that do not function predominantly in the same portion of the UV spectrum as the UV absorber.

Although one of the most important uses of material according to the invention is for use in security documents and security paper, the material can have any application where the fluorescent colour variation is useful or desirous. One such example would be as a means of generating signs or illuminating switches or dials. For such a use of the composite material multiple layers of ultraviolet masked fluorescent coatings can be used to generate alternative lights or symbols when illuminated from a surface or an edge of the material.

One example of a stacked material is shown in Fig. 4 which has two substrates 11a, 11b. Each substrate 11a, 11b is coated with a fluorescent coating 12, 13 incorporating a fluorescent pigment or dye which is different in each coating 12, 13. On each fluorescent coating 12, 13 is provided an ultraviolet absorbent layer of coating 14a, 14b. The layers of substrate 11a, 11b are positioned relative to each other so that a portion of the lower layer 11b

is uncovered by the upper layer 11a.

The fluorescent coatings 12, 13 have a refractive index at or near that of the substrate 11a, 11b and the refractive index of the ultraviolet absorbing layers 14a, 14b are sufficiently different from the adjacent coating 12, 13 to minimise ultraviolet leakage from the composite material 10 when illuminated. The substrates 11a, 11b are transparent and the fluorescent coatings 12, 13 are as transparent to visible light as possible.

When ultraviolet light is applied to the edge of the composite material 10, from arrow C, the substrate 11b acts as a light guide and coating 13 fluoresces. The ultraviolet absorbent layer 14b prevents leakage of any ultraviolet light from the substrate 11b to stop it from illuminating the fluorescent coating 12. The colour of coating 13 can be seen from a position at arrow E along the whole of the composite material 10.

If the composite material 10 is lit with ultraviolet light from the edge at arrow D, the upper substrate 11a will act as the light guide and the fluorescent colour of coating 12 will be seen along a section of the material 10, which the unlit section will be clear.

Simultaneous lighting at C and D will cause the colour of fluorescent coating 13 to be seen in the exposed region of substrate 11b and the colour of fluorescent coating 12 to be seen from the stacked region.

With such stacked materials a viewer facing the film may see a range of colours depending on the specific light path that are illuminated with ultraviolet light and the number of layers used.

The stacked composite material 10 may also be modified by printing the fluorescent coatings 12, 13 onto the substrates 11a, 11b to give a specific image, text or other indicia. In this way multiple images can be generated, simultaneously or separately over the same area. This is not possible with images generated by visible light as adjacent layers would interfer with one another. In this case it would not be necessary for each fluorescent layer to fluoresce at a different wavelength.

Examples of the composite material according to the invention can be made as follows:-

EXAMPLE 1

A 75 gsm waterleaf cotton rag paper containing 2% titanium dioxide was printed with the following UV curable resin formulation by a process of screen printing:-

- 94.9 parts by weight of a UV curable polyetheracrylate resin, LR 8869(TM) supplied by BASF;
- 2 parts by weight of a photoinitiator, Daracure 1173(TM) supplied by Ciba Geigy;
- 1 part by weight of a photoinitiator, Lucerin 8893(TM) supplied by BASF;
- 2 parts by weight of a red fluorescent pigment cd 316(TM) supplied by Reidel de Haen;

- 0.1 parts by weight of a blue fluorescent dye Uvitex OB(TM) supplied by Ciba Geigy.

The resin was allowed to soak into the paper for a few seconds before being cured by two passes under a medium pressure mercury UV lamp, one with the top side facing the lamp, the other with the bottom side facing the lamp. The energy applied to each surface was 5 joules cm^{-2}. The paper was then sized with polyvinyl alcohol and calendered.

When viewed from the printed side, transmitted UV light revealed a blue printed image and reflected UV light revealed a red printed image.

EXAMPLE 2

A 75 gsm waterleaf cotton rag paper containing 2% titanium dioxide was printed with the following UV curable resin formulation by a process of screen printing:-

- 94.9 parts by weight of a UV curable polyetheracrylate resin, LR 8869(TM) supplied by BASF;
- 2 parts by weight of a photoinitiator, Daracure 1173(TM) supplied by Ciba Geigy;
- 1 part by weight of a photoinitiator, Lucerin 8893(TM) supplied by BASF;
- 2 parts by weight of a green/yellow fluorescent pigment cd 397(TM) supplied by Reidel de Haen;
- 0.1 parts by weight of a blue fluorescent dye Uvitex OB(TM) supplied by Ciba Geigy.

The resin was allowed to soak into the paper for

a few seconds before being cured by two passes under a medium pressure mercury UV lamp, one with the top side facing the lamp, the other with the bottom side facing the lamp. The energy applied to each surface was 5 joules cm^{-2}. The paper was then sized with polyvinyl alcohol and calendered.

When viewed from the printed side, transmitted UV light revealed a blue printed image and reflected UV light revealed a green printed image.

EXAMPLE 3

A 75 gsm waterleaf cotton rag paper containing no titanium dioxide was printed with the following UV curable resin formulation by a process of screen printing.

- 93.9 parts by weight of a UV curable polyetheracrylate resin, LR 8869(TM) supplied by BASF;
- 2 parts by weight of a photoinitiator, Daracure 1173(TM) supplied by Ciba Geigy;
- 1 part by weight of a photoinitiator, Lucerin 8893(TM) supplied by BASF;
- 2 parts by weight of a red pigment cd 316(TM) supplied by Reidel de Haen;
- 0.1 parts by weight of a blue fluorescent dye Uvitex OB(TM) supplied by Ciba Geigy;
- 1 part by weight of a soluble UV absorber of the hydroxyphenlbenzotriazole class, Tinovin 1130(TM) supplied by Ciba Geigy.

The resin was allowed to soak into the paper for a few seconds before being cured by two passes

under a medium pressure mercury UV lamp, one with the top side facing the lamp, the other with the bottom side facing the lamp. The energy applied to each surface was 5 joules cm^{-2}. The paper was then sized with polyvinyl alcohol and calendered.

When viewed from the printed side, transmitted UV light revealed a blue printed image and reflected UV light revealed a blue printed image.

EXAMPLE 4

A 75 gsm titanium dioxide coated film of polyester was printed on both sides with the following UV curable resin formulations by a process of screen printing. Both prints were registered directly opposite each other.

Top side coating formulation.

- 96 parts by weight of a UV curable polyetheracrylate resin, LR 8869(TM) supplied by BASF;
- 2 parts by weight of a photoinitiator, Daracure 1173(TM) supplied by Ciba Geigy;
- 2 parts by weight of a red fluorescent pigment cd 316(TM) supplied by Reidel de Haen.

Bottom side coating formulation.

- 97.9 parts by weight of a UV curable polyetheracrylate resin, LR 8869(TM) supplied by BASF;
- 2 parts by weight of a photoinitiator, Daracure 1173(TM) supplied by Ciba Geigy;
- 0.1 parts by weight of a blue fluorescent dye Uvitex OB(TM) supplied by Ciba Geigy.

Each side was cured by one pass under a medium pressure mercury UV lamp. The energy applied to each surface was 5 joules cm^{-2}.

When viewed from the top side (printed with cd 316), transmitted UV light revealed a blue printed image and reflected UV light revealed a red printed image.

CLAIMS:

1. A composite material having fluorescent features comprising a transparent or translucent substrate, at least two fluorescent components, which fluorescent components fluoresce in ultraviolet light at different visible colours, and at least one ultraviolet light absorbent component is incorporated with one of the fluorescent components or alternatively between them.

2. A composite material as claimed in claim 1 of which at least one of the fluorescent components is incorporated in a fluorescent layer on a part of or the whole of one surface of the substrate.

3. A composite material as claimed in claim 2 in which the other fluorescent component is incorporated in a fluorescent layer on a part of or the whole of an opposite side of the substrate.

4. A composite material as claimed in claim 2 in which the other fluorescent component is incorporated in the substrate.

5. A composite material as claimed in any one of the preceding claims in which the ultraviolet light absorbent component is contained in the substrate.

6. A composite material as claimed in any one of claims 2 to 4 in which the ultraviolet light absorbent component is incorporated in a layer between the substrate and one fluorescent layer.

7. A composite material as claimed in any one of the preceding claims in which an ultraviolet light absorbent component is incorporated in a layer between each of the fluorescent coatings and the substrate.

8. A composite material as claimed in any one of the preceding claims further comprising a plurality of layers of substrate, on a surface of each of which is a fluorescent layer and layer of ultraviolet absorber and in which each fluorescent layer is positioned between an ultraviolet absorbent layer and a layer of substrate.

9. A composite material as claimed in any one of the preceding claims in which the fluorescent component(s) is(are) applied to the material in the form of one or more images, text or other indicia.

10. A composite material as claimed in any one of the preceding claims in which the fluorescent component(s) is(are) partially over-printed with an ultraviolet light absorbent component.

11. A composite material as claimed in any one of the preceding claims in which the substrate is a porous material.

12. A composite material as claimed in any one of the preceding claims in which the substrate is paper or non-woven or plastic film.

13. A method of making a composite material comprising the steps of applying a resin composition to a porous transparent or translucent substrate, which composition comprises a fluorescent pigment and

a fluorescent dye, which pigment and dye fluoresce at different visible colours.

14. A method as claimed in claim 13 in which the resin composition further comprises an ultraviolet light absorbent component.

15. A method as claimed in claim 13 in which an ultraviolet light absorbent component is contained within the substrate.

16. A composite material substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

17. A method of making a composite material substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

The Patent Office

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Application No: GB 9509473.6 **Examiner:** G J W Russell
Claims searched: 1-17 **Date of search:** 5 September 1995

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.N): B6A (AK, ATC)

Int Cl (Ed.6): B42D 15/00; D21H21/48; G03C 5/08

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2189800 A	(WEST) see page 3 lines 21-35	1,2,4,13
A	US 5120088	(NEW HOLDING) see column 2 lines 65-68	1,13
A	US 4897300	(GAO) see column 1 lines 44-58	1,13

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.